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[54] **USE OF PARATHORMONE, ITS BIOLOGICALLY ACTIVE FRAGMENTS AND CORRELATED PEPTIDES, FOR THE PREPARATION OF PHARMACEUTICAL COMPOSITIONS USEFUL FOR THE TREATMENT OF PREGNANCY**

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Oct. 9, 1992 [IT] Italy MI92A2231

[51] **Int. Cl.⁶** **A61K 38/00**

[52] **U.S. Cl.** **514/12; 514/21**

[58] **Field of Search** 514/12, 21

[56] **References Cited**

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[57]

ABSTRACT

Pharmaceutical compositions containing Parathormone as active ingredient, its biologically active fragments and correlated peptides (PTHrP), eventually in combination with appropriate pharmaceutically acceptable additives, useful in the prevention and therapy of abortion and of premature birth and in general for the treatment of pregnancy are described.

16 Claims, 4 Drawing Sheets

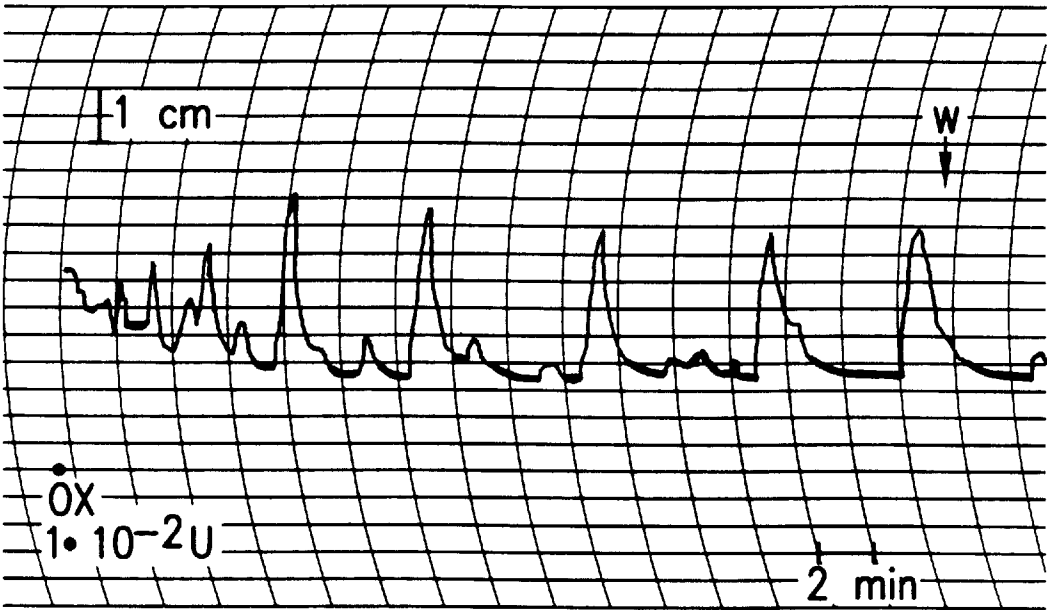


FIG. 1

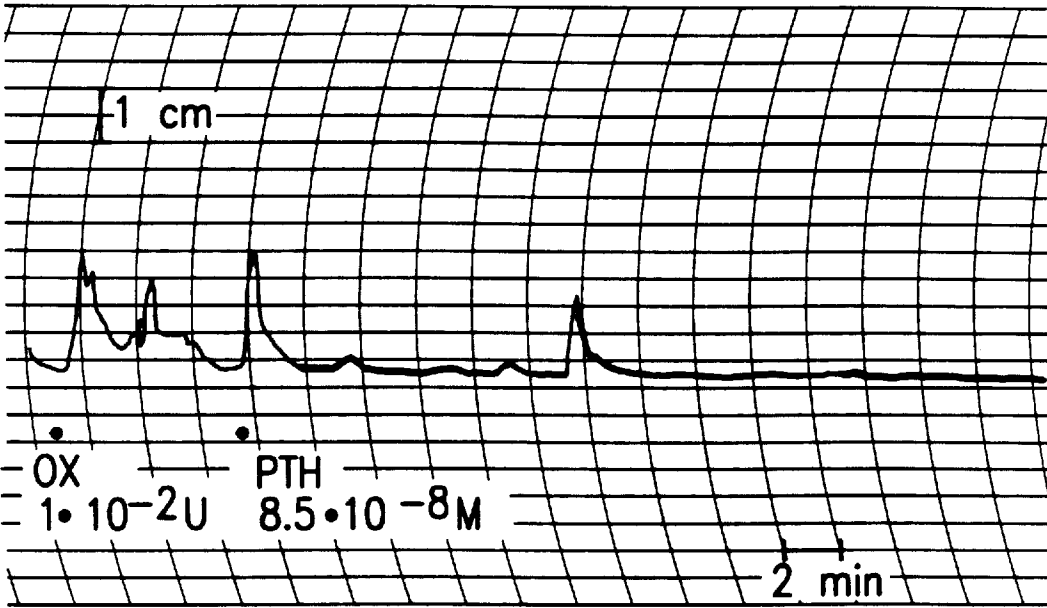


FIG. 2

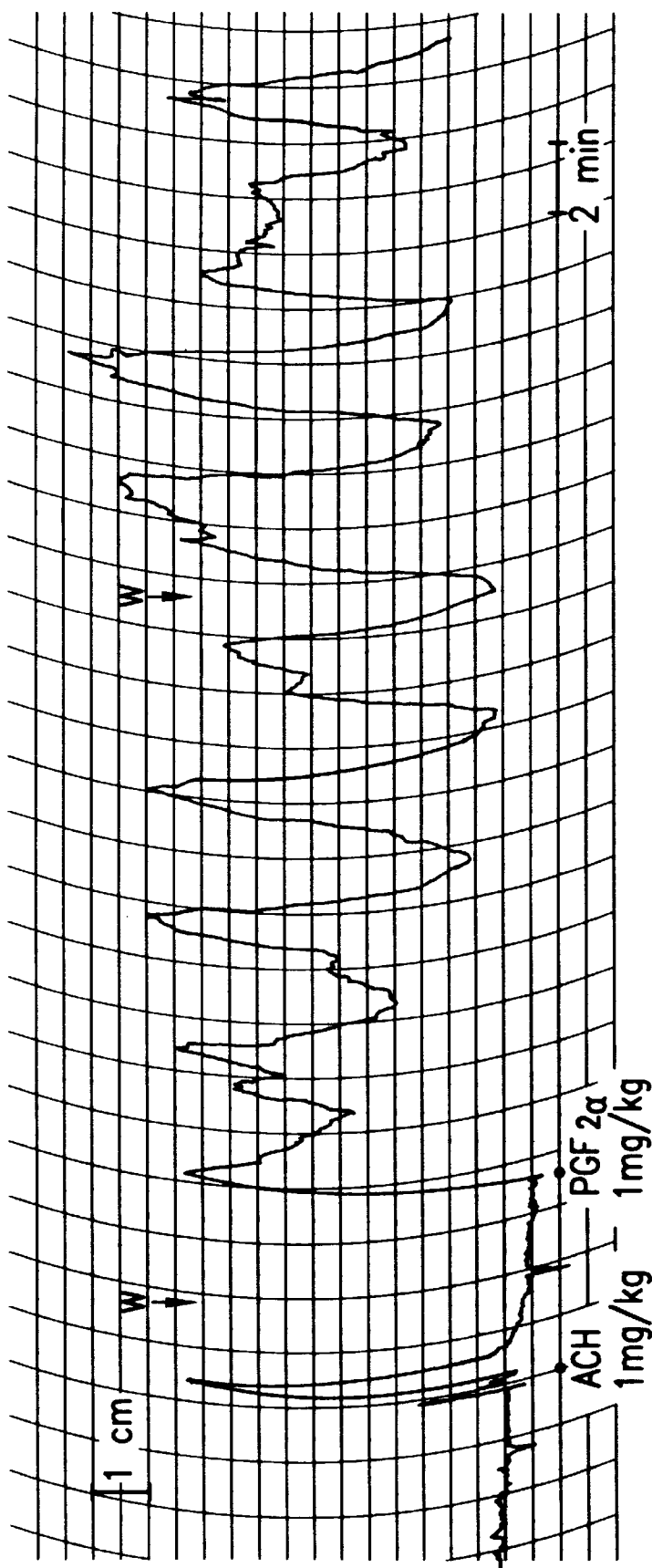


Fig. 3

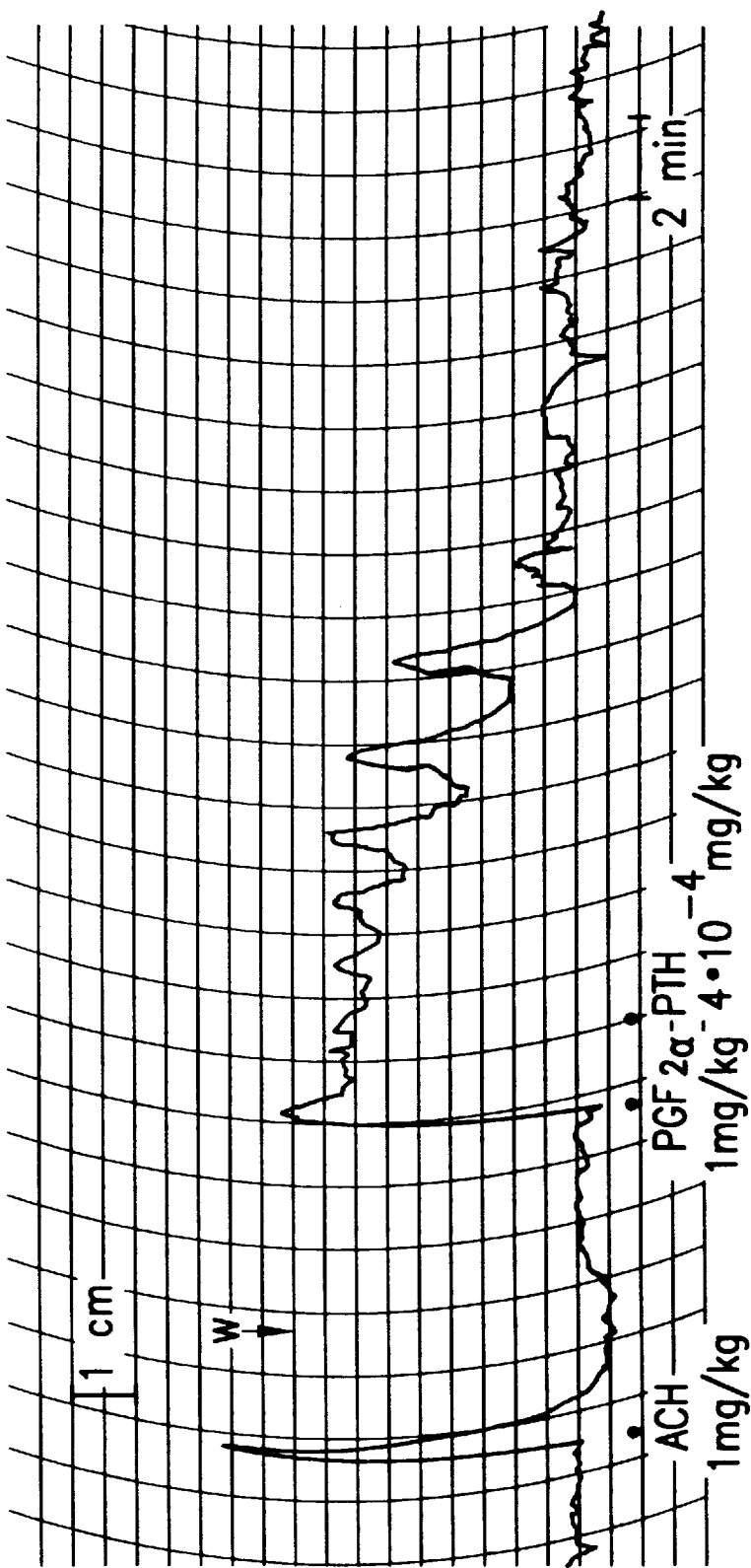


Fig. 4

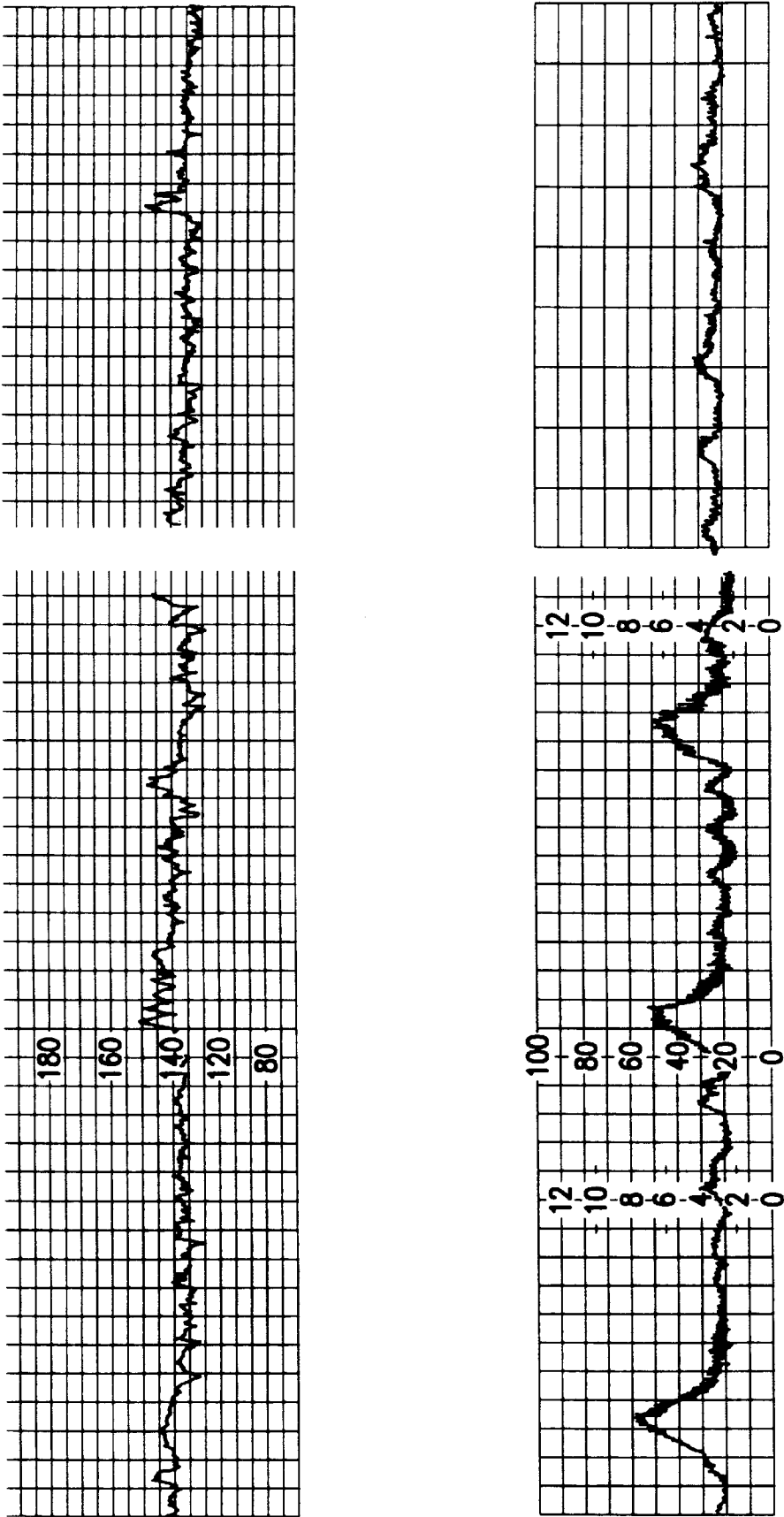


Fig. 5

USE OF PARATHORMONE, ITS BIOLOGICALLY ACTIVE FRAGMENTS AND CORRELATED PEPTIDES, FOR THE PREPARATION OF PHARMACEUTICAL COMPOSITIONS USEFUL FOR THE TREATMENT OF PREGNANCY

FIELD OF INVENTION

The present invention relates to the use of Parathormone, its biologically active fragments and its correlated peptides (PTHrP) for the prevention and therapy of abortion and of premature birth and in general for the treatment of pregnancy.

BACKGROUND OF THE INVENTION

The generic term Parathormone or parathyroid hormones (commonly indicated by the initials PTH eventually followed by the number of amino acids characterizing the particular fragment) refers to a series of proteins or their fragments which can be found in nature and are assigned to different physiological effects.

Such effects relate principally to the regulation of calcemic homeostasis, favouring the intestinal calcium absorption by the indirect mechanism of hydroxylation of Vitamin D, increasing the re-absorption of calcium in the renal tubules and activating the osteoclasts. More recently it was shown that PTH and PTHrP have a relaxing action on the gastrointestinal muscles and on vascular tissue. Moreover, an increase of hematic flow in the coronaries and a positive chronotropic effect and negative inotropic effect have been demonstrated.

The hormone and its fragments are dosed biologically and the measurement system presently most often used is the USP unit defined as one hundredth of the amount of parathyroid hormone required to increase the calcium contained in 100 ml of normal dog serum by 1 mg within 16–18 hours from administration.

Some studies reported in the literature indicate an in vitro action of parathormone, its fragments and the correlated peptide (PTHrP) on the contractility of rat uterus. According to such studies PTH has an inhibitory action on the contractility of the uterus induced by oxytocin, acetylcholine and prostaglandin.

Literature does not report studies evaluating the action of PTH, its fragments or PTHrP on the contractility of human myometrium. Furthermore, the data reported above cannot suggest results obtainable on the human uterus because the structural and physiological differences between these two tissues do not allow any predictability.

The rat uterus is formed of fiber cells which are completely different from those of the human myometrium. It was, therefore, not possible, according to such studies, to foresee the possibility of using such products in the prevention of abortion and premature birth in humans, since the data obtained in animals cannot be extrapolated to humans. In fact, the smooth muscles (including the human myometrium) do not normally possess fast Na⁺ channels, while the existence of such channels has been demonstrated in the rat uterus. Sperelakis N. et al., "Fast Na⁺ channels in smooth muscle from pregnant rat uterus," *Can. J. Physiol. Pharmacol.* (70) 491–500 (1992). Furthermore, although the concentration of receptors for oxytocin on myometrium membranes is quantitatively similar in human and guinea pig uterus, it was approximately twice that found in rat. Fuchs A. R. et al., "Oxytocin antagonist and oxytocin

receptors in myometrium and decidua," *Am. J. Perinatol.* (6), 205–208 (1989). Moreover, Lopez Bernal A. et al. have confirmed that oxytocin does not contract the nonpregnant human uterus but contracts the non-pregnant rat uterus.

Lopez Bernal A. et al., "Are leukotrienes involved in human uterine contractility?" *Br. J. Obstet. Gynaecol.* (96) 568–573 (1989).

We must also consider the remarkable structural differences of the two organs involved. In fact, the response of a sample of rat uterus is mostly due to the activity of longitudinal muscles while the response of human myometrium strips results from different muscular components. In addition, the behaviour of the two myometria with respect to histamine is well known. The rat uterus in estrus responds to histamine with an inhibition which is connected to the activation of H₂ receptors. Black J. W. et al., "Definition and Antagonism of histamine H₂-receptors," *Nature* (236), 385–390 (1972). The human uterus always reacts with a contraction due to the activation of H₁ receptors. Cruz M. et al., "Effects of histamine and serotonin on the contractility of isolated pregnant and nonpregnant human myometrium," *Gynecol. Obstet. Invest.* (28), 1–4 (1989).

Furthermore, G. Ballejo et al. have demonstrated that the response of the myometrium can depend on the animal species since the sensitivity to calcium in human uterus and in nonpregnant dog uterus did not result to be different, while in the nonpregnant rat myometrium the potency of CaCl₂ in inducing contractions in a solution rich of K⁺ and Ca²⁺ was about 30–40 times higher than that shown in their studies on human myometrium. G. Ballejo et al., "In vitro effects of calcium entry blockers, chlorpromazine and fenoterol upon human pregnant myometrium contractility," *Br. J. Pharmacol.* (89), 515–523 (1986); Calixto J. B. e Antonio A., "Effects of Compound D600 (methoxyverapamil) on drug-induced contractions of isolated dog uterine muscle," *Gen. Pharmacol.* (17), 203–209 (1986); Calixto J. B. and Loch S., "Ketamine inhibition of calcium-induced contractions in depolarized uterus. A comparison with other calcium antagonists," *Br. J. Pharmacol.* (85), 189–195 (1985). In conclusion, therefore, the effects observed on the human uterus cannot be extrapolated from those obtained on the rat uterus but, rather, the effect noted in vitro on human uterus is surprising.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the protracted stimulation of contractions induced on human myometrium, by oxytocin (Ox) at a dose of 1×10^{-2} U

FIG. 2 shows the inhibitory effect (flat trace) induced by intact human parathormone at a dose of 8.5×10^{-8} M on human myometrium stimulated with oxytocin at a dose of 1×10^{-2} U.

FIG. 3 shows typical contractions induced by PGF²alpha (1 mg/kg) indicating intensity and duration.

FIG. 4 shows the response at the same dosage as in FIG. 3 after administration of intact human PTH at a dose of 4×10^{-4} mg/kg.

FIG. 5 reports on the left side the basal value of uterine contractility and fetal heart rate in a pregnant woman; the same parameters after 10 infusion with PTH 200 U are reported on the right side.

In the figures the dots (·) indicate the moment of administration of the indicated substance; W (Washing) indicates the washing of the preparation.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to the use of Parathormone, its active fragments or correlated peptides for the prevention

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of abortion and premature birth and in general for the treatment of pregnancy. For the purposes of the present invention the following are particularly indicated: PTH, PTH 1–34, PTH 1–13, PTH 38–64, PTH 67–86, PTHrP.

The compositions can be formulated for intravenous, intramuscular, subcutaneous, rectal and vaginal administration. The types of formulations can be briefly summarized as follows: an injectable pharmaceutical form in which the active ingredient is in the liquid phase or, preferably lyophilized, in the presence eventually of an appropriate stabilizing agent (albumin, peptone, PVP, etc.), an appropriate support (in case of lyophilized product: lactose, mannitol, glycine, etc.) and of a buffer mixture capable of assuring the most appropriate pH for its stability; a rectal pharmaceutical formulation represented by a suppository or preferably a soft gelatine capsule containing the active ingredient suspended in a mixture of water soluble excipients including essentially polyethylene glycols and/or propyleneglycols having the necessary fluidity, with the addition of a polyalcohol such as glycerin and eventually a stabilizing agent (albumin, peptone, PVP, etc.) and a buffer mixture necessary to maintain the pH in a range of values compatible with PTH and/or its active fragments; a vaginal pharmaceutical formulation such as a vaginal suppository or preferably soft gelatine vaginal ovule containing the active ingredient suspended in a mixture of water soluble excipients essentially similar to that contained in the soft gelatine capsule for rectal use.

The quantity of active ingredient can vary between 100 to 1000 Units, but is preferably between 400 and 800 Units. The following examples describe pharmaceutical formulations containing PTH or its biologically active fragments, which can be used by injection (Examples 1–6), rectal administration (Examples 7–14) and vaginal administration (Examples 15–18). The doses indicated refer to a formulation which can be used for the preparation of 1000 vials, rectal capsules or vaginal capsules.

EXAMPLE 1

PTH (or fragment thereof)	100000 U (USP)
Lactose	10.0 g
Phosphate-citrate buffer pH 2.5–3	7.5 g
Water for injections (USP) q.s. to 1000 ml	

EXAMPLE 2

PTH (or fragment thereof)	100000 U (USP)
Lactose	10.0 g
Human albumin	20.0 g
Phosphate-citrate buffer pH 2.5–3	7.5 g
Water for injections (USP) q.s. to 1000 ml	

EXAMPLE 3

PTH (or fragment thereof)	500000 U (USP)
Mannitol	15.0 g
PVP	15.0 g
Phosphate-citrate buffer pH 2.5–3	7.5 g
Water for injections (USP) q.s. to 1000 ml	

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EXAMPLE 4

PTH (or fragment thereof)	750000 U (USP)
Glycine	25.0 g
Peptone	25.0 g
Phosphate-citrate buffer pH 2.5–3	7.5 g
Water for injections (USP) q.s. to 1000 ml	

EXAMPLE 5

PTH (or fragment thereof)	400000 U (USP)
Human albumin	25.0 g
Phosphate-citrate buffer pH 2.5–3	7.5 g
Water for injections (USP) q.s. to 1000 ml	

EXAMPLE 6

PTH (or fragment thereof)	400000 U (USP)
Lactose	10.0 g
Human albumin	25.0 g
Phosphate-citrate buffer pH 2.5–3	7.5 g
Water for injections (USP) q.s. to 1000 ml	

EXAMPLE 7

PTH (or fragment thereof)	500000 U (USP)
Human albumin	20.0 g
Phosphate-citrate buffer pH 2.5–3	7.5 g
Glycerin	50.0 g
Polyethylene glycol 600	900.0 g
Polyethylene glycol 4000	75.0 g
Purified Water	2.0 g

EXAMPLE 8

PTH (or fragment thereof)	750000 U (USP)
Human albumin	10.0 g
Phosphate-citrate buffer pH 2.5–3	7.5 g
Glycerin	50.0 g
Polyethylene glycol 600	900.0 g
Polyethylene glycol 4000	75.0 g
Purified Water	2.0 g

EXAMPLE 9

PTHrP (or fragment thereof)	500000 U (USP)
Human albumin	15.0 g
Phosphate-citrate buffer pH 2.5–3	7.5 g
Glycerin	50.0 g
Polyethylene glycol 600	900.0 g
Polyethylene glycol 4000	75.0 g
Purified Water	2.0 g

EXAMPLE 10

PTH (or fragment thereof)	500000 U (USP)
Human albumin	20.0 g
Phosphate-citrate buffer pH 2.5–3	7.5 g
Glycerin	40.0 g

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-continued

Polyethylene glycol 400	250.0 g
Polyethylene glycol 200	500.0 g
Polyethylene glycol 4000	100.0 g
Sorbitol	10.0 g
Purified Water	5.0 g

EXAMPLE 11

PTH (or fragment thereof)	500000 U (USP)
Human albumin	15.0 g
Glycerin	50.0 g
Phosphate-citrate buffer pH 2.5-3	15.0 g
Polyethylene glycol 600	900.0 g
Polyethylene glycol 4000	75.0 g

EXAMPLE 12

PTHrP	500000 U (USP)
Human albumin	15.0 g
Glycerin	50.0 g
Phosphate-citrate buffer pH 2.5-3	15.0 g
Polyethylene glycol 600	900.0 g
Polyethylene glycol 4000	75.0 g

EXAMPLE 13

PTH (or fragment thereof)	500000 U (USP)
Peptone	15.0 g
Glycerin	50.0 g
Phosphate-citrate buffer pH 2.5-3	15.0 g
Polyethylene glycol 600	900.0 g
Polyethylene glycol 4000	75.0 g
Purified Water	2.0 g

EXAMPLE 14

PTH (or fragment thereof)	500000 U (USP)
PVP	15.0 g
Glycerin	50.0 g
Phosphate-citrate buffer pH 2.5-3	15.0 g
Polyethylene glycol 600	900.0 g
Polyethylene glycol 4000	75.0 g
Purified Water	2.0 g

EXAMPLE 15

PTH (or fragment thereof)	500000 U (USP)
Human albumin	20.0 g
Glycerin	80.0 g
Phosphate-citrate buffer pH 2.5-3	25.0 g
Polyethylene glycol 600	2500.0 g
Polyethylene glycol 4000	300.0 g
Purified Water	2.0 g

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EXAMPLE 16

PTHrP	500000 U (USP)
Human albumin	20.0 g
Glycerin	80.0 g
Phosphate-citrate buffer pH 2.5-3	15.0 g
Polyethylene glycol 600	2500.0 g
Polyethylene glycol 4000	300.0 g
Purified Water	2.0 g

EXAMPLE 17

PTH (or fragment thereof)	500000 U (USP)
Peptone	25.0 g
Glycerin	80.0 g
Phosphate-citrate buffer pH 2.5-3	25.0 g
Polyethylene glycol 600	2500.0 g
Polyethylene glycol 4000	300.0 g
Purified Water	2.0 g

EXAMPLE 18

PTH (or fragment thereof)	500000 U (USP)
PVP	25.0 g
Glycerin	80.0 g
Phosphate-citrate buffer pH 2.5-3	25.0 g
Polyethylene glycol 600	2500.0 g
Polyethylene glycol 4000	300.0 g
Purified Water	2.0 g

Experimental Trials on the in vitro motility of fragments of myometrium of pregnant women

By using "in vitro" fragments of myometrium taken during Caesarean birth according to the technique described in "IL FARMACO", Edizione Scientifica, 31: pages 329-336 (1976), a net inhibitory effect on contraction induced by oxytocyn has been observed, as can be seen in FIGS. 1 and 2 attached. In FIG. 2 there is a net inhibitory effect, indicated in the flat trace, induced by intact human Parathormone (PTH) at a dose of $8.5 \times 10^{-8} \text{M}$, on human myometrium stimulated with oxytocyn at a dose of $1 \times 10^{-2} \text{U}$. The inhibitory effect induced by PTH is particularly evident when compared with the protracted stimulation of contractions induced by oxytocyn (Ox) at a dose of $1 \times 10^{-2} \text{U}$ (FIG. 1).

Furthermore, Parathormone, has also been essayed for the contractions induced by PGF2alpha according to the technique described in the British Journal of Pharmacology 93: 185-191 (1988). FIG. 3 shows a typical contraction induced by PGF2alpha (1 mg/kg) indicating intensity and duration. If we compare the same response at the same dosage on FIG. 4 we can see a clear inhibitory effect both in terms of intensity and duration as a result of administration of whole human PTH at a dose of $4 \times 10^{-4} \text{mg/Kg}$.

In the graphs the dots (·) indicate the moment of administration of the substance indicated. The letter W (Washing) indicates the washing of the preparation.

Experimental clinical effects

Three pregnant women having symptoms indicating the likelihood of premature birth have been observed while in their 34-36th week of pregnancy. The patients underwent a

cardiotocography which showed waves revealing uterine contractions. Arterial pressure, heart rate and skin coloring were evaluated. The women were clearly aware of the contractions and of the pain caused by such contractions.

The women were administered 100 Units of synthetic Parathormone 1–34 (two vials according to Examples 1 and 2) by rapid infusion (10 minutes), diluted in 200 cc of physiological solution. Two blood samples were taken before and after infusion and the serum was frozen and stored at –20° C. for the evaluation of the mineral elements (calcium, phosphorous, magnesium, alkaline phosphatase, parathormone, progesterone, estradiol). The results have

shown the efficacy of Parathormone on uterine contractility while no side effects have been noted either in the mother or the fetus.

In particular, the cardiotocography has shown the disappearance of waves referring to uterine contractions during the period of monitoring (40 minutes); the fetal heart beat did not show variations and remained within the normal limits (FIG. 5). The patients indicated the immediate disappearance of uterine contractions and of pain caused by the same contractions, particularly in the lumbar-sacral region and reported also a feeling of well-being and decreased abdominal weight. The arterial pressure and heart rate did not show variations of worthwhile note and no side effects were noted in relation to the infusion of the drug.

SEQUENCE LISTING

(1) GENERAL INFORMATION:

(i i i) NUMBER OF SEQUENCES: 5

(2) INFORMATION FOR SEQ ID NO: 1:

- (i) SEQUENCE CHARACTERISTICS:
 - (A) LENGTH: 84 amino acids
 - (B) TYPE: amino acid
 - (C) STRANDEDNESS: single
 - (D) TOPOLOGY: linear

(i i) MOLECULE TYPE: protein

(x i) SEQUENCE DESCRIPTION: SEQ ID NO: 1:

Ser Val Ser Glu Ile Gln Leu Met His Asn Leu Gly Lys His Leu Asn
5 10
Ser Met Glu Arg Val Glu Trp Leu Arg Lys Lys Leu Gln Asp Val His
20 25 30
Asn Phe Val Ala Leu Gly Ala Pro Leu Ala Pro Arg Asp Ala Gly Ser
35 40 45
Gln Arg Pro Arg Lys Lys Glu Asp Asn Val Leu Val Glu Ser His Glu
50 55 60
Lys Ser Leu Gly Glu Ala Asp Lys Ala Asp Val Asp Val Leu Thr Lys
65 70 75 80
Ala Lys Ser Gln

(2) INFORMATION FOR SEQ ID NO: 2:

- (i) SEQUENCE CHARACTERISTICS:
 - (A) LENGTH: 34 amino acids
 - (B) TYPE: amino acid
 - (C) STRANDEDNESS: single
 - (D) TOPOLOGY: linear

(i i) MOLECULE TYPE: protein

(x i) SEQUENCE DESCRIPTION: SEQ ID NO: 2:

Ser Val Ser Glu Ile Gln Leu Met His Asn Leu Gly Lys His Leu Asn
5 10 15
Ser Met Glu Arg Val Glu Trp Leu Arg Lys Lys Leu Gln Asp Val His
20 25 30
Asn Phe

(2) INFORMATION FOR SEQ ID NO: 3:

-continued

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 13 amino acids

(B) TYPE: amino acid

(C) STRANDEDNESS: single

(D) TOPOLOGY: linear

(i i) MOLECULE TYPE: protein

(x i) SEQUENCE DESCRIPTION: SEQ ID NO: 3:

SerValSerGluIleGlnLeuMetHisAsnLeuGlyLys

510

(2) INFORMATION FOR SEQ ID NO: 4:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 20 amino acids

(B) TYPE: amino acid

(C) STRANDEDNESS: single

(D) TOPOLOGY: linear

(i i) MOLECULE TYPE: protein

(x i) SEQUENCE DESCRIPTION: SEQ ID NO: 4:

TyrLeuThrGlnGluThrAsnLysValGluThrTyrLysGluGlnPro

51015

LeuLysThrPro

20

(2) INFORMATION FOR SEQ ID NO: 5:

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 141 amino acids

(B) TYPE: amino acid

(C) STRANDEDNESS: single

(D) TOPOLOGY: linear

(i i) MOLECULE TYPE: protein

(x i) SEQUENCE DESCRIPTION: SEQ ID NO: 5:

AlaValSerGluHisGlnLeuLeuHisAspLysGlyLysSerIleGln

51015

AspLeuArgArgArgPhePheLeuHisHisLeuIleAlaGluIleHis

202530

ThrAlaGluIleArgAlaThrSerGluValSerProAsnSerLysPro

354045

SerProAsnThrLysAsnHisProValArgPheGlySerAspAspGlu

505560

GlyArgTyrLeuThrGlnGluThrAsnLysValGluThrTyrLysGlu

65707580

GlnProLeuLysThrProGlyLysLysLysLysGlyLysProGlyLys

859095

ArgLysGluGlnGluLysLysLysArgArgThrArgSerAlaTrpLeu

100105110

AspSerGlyValThrGlySerGlyLeuGluGlyAspHisLeuSerAsp

115120125

ThrSerThrThrSerLeuGluLeuAspSerArgArgHis

130135140

I claim:
1. A method for preventing premature birth or spontaneous abortion comprising administering to a pregnant human patient in need thereof a composition comprising a therapeutically effective amount of parathormone, PTHrP or a biologically active fragment of parathormone.

2. The method of claim 1 wherein the parathormone, PTHrP or biologically active fragment of parathormone is selected from the group consisting of PTH, PTH 1–34, PTH 1–13, PTH 38–64, PTH 67–86 and PTHrP.

3. The method of claim 1 wherein parathormone is administered to the patient.

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4. The method of claim 1 wherein the composition further comprises a pharmaceutically acceptable carrier.

5. The method of claim 1 wherein the composition is administered intravenously, intramuscularly, subcutaneously, rectally or vaginally.

6. The method of claim 1 wherein the composition comprises from about 100 to about 1000 U (USP) of parathormone, PTHrP or a biologically active fragment of parathormone.

7. The method of claim 1 wherein the composition comprises from about 400 to about 800 U (USP) parathormone, PTHrP or a biologically active fragment of parathormone.

8. A method for treating unwanted uterine contractions in a pregnant human patient comprising administering to said patient a pharmaceutical composition comprising a therapeutically effective amount of parathormone, PTHrP or a fragment of parathormone having human myometrium regulating activity.

9. The method of claim 8 wherein the parathormone, PTHrP or biologically active fragment of parathormone is selected from the group consisting of PTH, PTH 1-34, PTH 1-13, PTH 38-64, PTH 67-86 and PTHrP.

10. The method of claim 8 wherein parathormone is administered to the patient.

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11. The method of claim 8 wherein the composition further comprises a pharmaceutically acceptable carrier.

12. The method of claim 8 wherein the composition is administered intravenously, intramuscularly, subcutaneously, rectally or vaginally.

13. The method of claim 8 wherein the composition comprises from about 100 to about 1000 U (USP) of parathormone, PTHrP or a biologically active fragment of parathormone.

14. The method of claim 8 wherein the composition comprises from about 400 to about 800 U (USP) parathormone, PTHrP or a biologically active fragment of parathormone.

15. A pharmaceutical composition for preventing premature birth, spontaneous abortion or treating unwanted uterine contractions consisting essentially of from about 100 to about 1000 U (USP) of parathormone, PTHrP or biologically active fragment of parathormone.

16. The composition of claim 15 consisting essentially of from about 400 to about 800 U (USP) parathormone, PTHrP or a biologically active fragment of parathormone.

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